UG COURSE CURRICULUM
AND
SYLLABI
UNDER CHOICE BASED CREDIT SYSTEM

GEOLOGY

Submitted to

ASSAM UNIVERSITY, SILCHAR

COURSE STRUCTURE
DETAILS OF COURSES FOR B.SC. (HONORS) GEOLOGY

Courses	***Credits**
	Theory+ Practical
I. Core Course	
Core Course Theory **(14 Papers)**	14X4= 56
Core Course Practical / Tutorial* **(14 Papers)**	14X2=28
II. Elective Course	
A.1. Discipline Specific Elective **(4 Papers)**	4X4=16
A.2. Discipline Specific Elective Practical/Tutorial* **(4 Papers)**	4 X 2=8
B.1. Generic Elective **(4 Papers)** to be chosen from other discipline	4X4=16
B.2. Generic Elective Practical/ Tutorial* (**Papers)**	4 X 2=8
III. Ability Enhancement Courses	
A.1. Ability Enhancement Compulsory **(2 Papers)**	
Environmental Science	1 X 4=4
English/MIL Communication	1 X 4=4
A.2. Ability Enhancement Elective (Skill Based) **(2 Papers)**	2 X 4=8
Total credit	**148**

- ***Each credit is equivalent to 1 hour of activity per week***

SCHEME FOR CHOICE BASED CREDIT SYSTEM IN
B. Sc. Honours (GEOLOGY)

SEMESTER	CORE COURSE (14)	Ability Enhancement Compulsory	Ability Enhancement Elective Course (AEEC) (2)	Elective: Discipline Specific DSE (4)	Elective: Generic GE (4) To be opted from other discipline
I	GEOLOGY -C-101	Eng/MIL Communication			GE-1
	GEOLOGY -C-102				
II	GEOLOGY -C-201	Environmental Science			GE-2
	GEOLOGY -C-202				
III	GEOLOGY -C-301		GEOLOGY -SEC-301		GE-3
	GEOLOGY -C-302				
	GEOLOGY -C-303				
IV	GEOLOGY -C-401		GEOLOGY -SEC-401		GE-4
	GEOLOGY -C-402				
	GEOLOGY -C-403				
V	GEOLOGY -C-501			GEOLOGY -DSE-501	
	GEOLOGY -C-502			GEOLOGY -DSE-502	
VI	GEOLOGY -C-601			GEOLOGY -DSE-601	
	GEOLOGY -C-602			GEOLOGY -DSE-602	

PROPOSED SCHEME FOR CHOICE BASED CREDIT SYSTEM IN
B. Sc. (General)

Course	Credits	
	Theory+ Practical	Theory+ Tutorial
I. Core Course		
Core Course Theory **(12 Papers)** 04 papers from each of the 03 disciplines of choice	12X4= 48	12X5=60
Core Course Practical / Tutorial* **(12 Practical/ Tutorials*)** 04 papers from each of the 03 Disciplines of choice	12X2=24	12X1=12
II. Elective Course		
Elective Course Theory **(6 Papers)** 02 papers from each discipline of choice	6x4=24	6X5=30
Elective Course Practical / Tutorials* **(6 Practical / Tutorials*)** 02 Papers from each discipline of choice	6 X 2=12	6X1=6
III. Ability Enhancement Courses		
Ability Enhancement Compulsory **(2 Papers)** Environmental Science English/MIL Communication	2 X 4=8	2X4= 8
Skill Enhancement Course (Skill Based) **(4 Papers)**	4 X 4=16	4X4=16
	Total credit= 132	**Total credit= 132**

- **Each credit is equivalent to 1 hour of activity per week**

SCHEME FOR CHOICE BASED CREDIT SYSTEM IN
B. Sc. with GEOLOGY

	CORE COURSE (12)	**Ability Enhancement Compulsory Course (AECC) (2)**	**Skill Enhancement Course (SEC)** (4)	**Discipline Specific Elective DSE (6)**
I	GEOLOGY-DSC-101 DSC- 2 A DSC- 3 A	Environmental Science		
II	GEOLOGY-DSC-201 DSC- 2 B	English/MIL Communication		
	DSC- 3 B			
III	GEOLOGY -DSC-301 DSC- 2 C DSC- 3 C		GEOLOGY -SEC-301	
IV	GEOLOGY -DSC-401 DSC- 2 D DSC- 3 D		GEOLOGY -SEC-401	
V			GEOLOGY -SEC-501	GEOLOGY -DSE-501 DSE-2 A DSE-3 A
VI			GEOLOGY -SEC-601	GEOLOGY -DSE-601 DSE-2 B DSE-3 B

Distribution of courses
Geology (Honours)
Core courses

SEM	Course No.	Course Name	Credit
I	GEOLOGY-C-101	Earth System Science	4
	GEOL -C-101-LAB	*Practical*	2
	GEOL -C-102	Mineral Science	4
	GEOL -C-102-LAB	*Practical*	2
II	GEOLOGY -C-201	Elements of Geochemistry	4
	GEOLOGY -C-201-LAB	*Practical*	2
	GEOLOGY -C-202	Structural Geology	4
	GEOLOGY -C-202-LAB	*Practical*	2
III	GEOLOGY -C-301	Igneous Petrology	4
	GEOLOGY -C-301-LAB	*Practical*	2
	GEOLOGY -C-302	Sedimentary Petrology	4
	GEOLOGY -C-302-LAB	*Practical*	2
	GEOLOGY -C-303	Palaeontology	4
	GEOLOGY -C-303-LAB	*Practical*	2
	GEOLOGY-SEC-301	Field Work-I	2
IV	GEOLOGY -C-401	Metamorphic Petrology	4
	GEOLOGY -C-401-LAB	*Practical*	2
	GEOLOGY -C-402	Stratigraphic Principles and Indian Stratigraphy	4
	GEOLOGY -C-402-LAB	*Practical*	2
	GEOLOGY -C-403	Hydrogeology	4
	GEOLOGY -C-403-LAB	*Practical*	2
	GEOLOGY-SEC-401	Field Work-II	2
V	GEOLOGY -C-501	Economic Geology	4
	GEOLOGY -C-501-LAB	*Practical*	2
	GEOLOGY -C-502	Geomorphology	4
	GEOLOGY -C-502-LAB	*Practical*	2
	GEOLOGY -DSE-501	Exploration Geology	4
	GEOLOGY-DSE-501-LAB	*Practical*	2
	GEOLOGY -DSE-502	Introduction To Geophysics	4
	GEOLOGY -DSE-502-LAB	*Practical*	2
VI	GEOLOGY -C-601	Engineering Geology	4
	GEOLOGY -C-601-LAB	*Practical*	2
	GEOLOGY -C-602	Remote Sensing & GIS	4
	GEOLOGY -C-602-LAB	*Practical*	2
	GEOLOGY -DSE-601	Fuel Geology	4
	GEOLOGY-DSE-601-LAB	*Practical*	2
	GEOLOGY-DSE-602	Evolution of Life Through Time / Dissertation	4
	GEOLOGY-DSE-602- LAB	Practical	2

Semester wise list of Geology Generic Elective papers for students taking honours in other disciplines

SEMESTER	COURSE OPTED	COURSE NAME	CREDITS
I	GEOLOGY-GE-101	Physical & Structural Geology	4
	GEOLOGY-GE-LAB-101	Physical & Structural Geology Lab	2
II	GEOLOGY-GE-201	Crystallography & Mineralogy	4
	GEOLOGY -GE-201-LAB	Crystallography & Mineralogy Lab	2
III	GEOLOGY-GE-301	Petrology	4
	GEOLOGY -GE-301-LAB	Petrology Lab	2
IV	GEOLOGY -GE-401	Stratigraphy & Paleontology	4
	GEOLOGY - GE -401-LAB	Stratigraphy & Paleontology Lab	2

Semester wise list of Geology papers to be studied by a B.Sc. student with Geology.

SEMESTER	COURSE NO.	Course Name	Credit
I	GEOLOGY-DSC-101	Physical & Structural Geology	*4*
	GEOLOGY-DSC-LAB-101	Physical & Structural Geology Lab	*2*
II	GEOLOGY-DSC-201	Crystallography & Mineralogy	4
	GEOLOGY-DSC-LAB-201	Crystallography & Mineralogy Lab	2
III	GEOLOGY-DSC-301	Petrology	4
	GEOLOGY-DSC-LAB-301	Petrology Lab	2
	GEOLOGY-SEC-301	Geomorphology & Geotectonics	4
IV	GEOLOGY-DSC-401	Stratigraphy & Paleontology	4
	GEOLOGY-DSC-LAB-401	Stratigraphy & Paleontology Lab	2
	GEOLOGY-SEC-401	Environmental Geology	4
V	GEOLOGY-DSE-501	Exploration Geology	4
	GEOLOGY-DSE-LAB-501	Exploration Geology Lab	2
	GEOLOGY-SEC-501	Geochemistry	4
VI	GEOLOGY- DSE-601	Engineering Geology	4
	GEOLOGY-DSE-LAB-601	Engineering Geology Lab	2
	GEOLOGY-SEC-601	Photogeology & Remote Sensing	4

CORE COURSES: GEOLOGY (HONOURS)

FIRST SEMESTER
Course No.: GEOLOGY-C 101
EARTH SYSTEM SCIENCE

(Contact Hours: 60; Credits: 04)

Full Marks = 70 **[**Semester End Exam (50) + Internal Assessment (20)]
Pass Marks = 28 **[**Semester End Exam (20) + Internal Assessment (08)]

Two questions are to be set from each unit. Students have to answer five questions taking one from each Unit

Unit 1: Earth as a planet
Holistic understanding of dynamic planet 'Earth' through Astronomy, Geology, Meteorology and Oceanography. Introduction to various branches of Earth Sciences. General characteristics and origin of the Universe, Solar System and its planets. The terrestrial and Jovian planets. Meteorites and Asteroids; Earth in the solar system - origin, size, shape, mass, density, rotational and revolution parameters and its age.

Unit 2: Earth's magnetic field
Earth's magnetic field, Formation of core, mantle, crust, hydrosphere, atmosphere and biosphere, Convection in Earth's core and production of its magnetic field, Mechanical layering of the Earth.

Unit 3: Plate Tectonics
Concept of plate tectonics, sea-floor spreading and continental drift. Geodynamic elements of Earth- Mid Oceanic Ridges, trenches, transform faults and island arcs Origin of oceans, continents, mountains and rift valleys, Earthquake and earthquake belts; Volcanoes- types, products and their distribution.

Unit 4: Hydrosphere and Atmosphere, Oceanic current system and effect of Coriolis force; Concepts of eustasy, Land-air-sea interaction, Wave erosion and beach processes. Atmospheric circulation, Weather and climatic changes, processes of formation, soil profile and soil types.

Unit 5: Understanding the past from stratigraphic records, Nature of stratigraphic records Standard stratigraphic time scale and introduction to the concept of time in geological studies Introduction to geochronological methods and their application in geological studies,History of development in concepts of uniformitarianism, catastrophism and neptunism. Laws of superposition and faunal succession

SUGGESTED READINGS:
1. Duff, P. M. D., & Duff, D. (Eds.). (1993). Holmes' principles of physical geology. Taylor & Francis.
2. Emiliani, C. (1992). Planet earth: cosmology, geology, and the evolution of life and environment. Cambridge University Press.
3. Gross, M. G. (1977). Oceanography: A view of the earth.

FIRST SEMESTER
Course No.: **GEOLOGY-C-101 Lab**
PRACTICALS

(40 Contact hours; Credits: 02)
Full marks: 30
Pass marks: 12 [Break-up as per AUS guidelines on CBCS]

Study of major geomorphic features and their relationships with outcrops through physiographic models.
Detailed study of topographic sheets and preparation of physiographic description of an area
Study of soil profile of any specific area
Study of distribution of major lithostratigraphic units on the map of India
Study of distribution of major dams on map of India and their impact on river systems
Study of major ocean currents of the World
Viva-Voce
Laboratory Record

FIRST SEMESTER
Course No.: GEOLOGY-C 102
MINERAL SCIENCE

(Contact Hours: 60; Credits: 04)

Full Marks = 70 **[**Semester End Exam (50 + Internal Assessment (20)]
Pass Marks = 28 **[**Semester End Exam (20) + Internal Assessment (08)]

Two questions are to be set from each unit. Students have to answer five questions taking one from each Unit

Unit 1: Crystallography
Elementary ideas about crystal morphology in relation to internal structures, Crystal parameters and indices, Crystal symmetry and classification of crystals into six systems and 32 point groups.

Unit 2: Crystal symmetry and projections
Elements of crystal chemistry and aspects of crystal structures, Stereographic projections of symmetry elements and forms.

Unit 3: Rock forming minerals
Minerals - definition and classification, physical and chemical properties, Composition of common rock-forming minerals, Silicate and non-silicate structures; CCP and HCP structures.

Unit 4: Properties of light and optical microscopy Nature of light and principles of optical mineralogy, Introduction to the petrological microscope and identification of common rock-forming minerals.

Unit 5: Refractive index and its determination; optical accessories- quartz wedge, gypsum plate and mica plate; types of extinction and determination of extinction angle; Optical Indicatrix- Uniaxial and Biaxial interference figures and optic sign determination, 2V and 2E.

SUGGESTED READINGS:
1. Klein, C., Dutrow, B., Dwight, J., & Klein, C. (2007). The 23rd Edition of the Manual of Mineral Science (after James D. Dana). J. Wiley & Sons.
2. Kerr, P. F. (1959). Optical Mineralogy. McGraw-Hill.
3. Verma, P. K. (2010). Optical Mineralogy. Ane Books Pvt Ltd.
4. Deer, W. A., Howie, R. A., & Zussman, J. (1992). An introduction to the rock-forming minerals (Vol. 696). London: Longman.
5. Winchel, A.N. 1968: Elements of optical mineralogy, part 1 & 2 Wiley Eastern.
6. Smith H.G.: Minerals under microscopy
7. Dana, 2003: Text Book of Mineralogy, Wiley Eastern Ltd.

FIRST SEMESTER
Course No.: **GEOLOGY-C-102 Lab**
PRACTICALS

(40 Contact hours; Credits: 02)
Full marks: 30
Pass marks: 12 [Break-up as per AUS guideline on CBCS]

Observation and documentation on symmetry of crystals
Study of physical properties of minerals in hand specimen
Silicates: Olivine, Garnet, Andalusite, Sillimanite, Kyanite, Staurolite, Beryl, Tourmaline, Augite, Actinolite, Tremolite, Hornblende, Serpentine, Talc, Muscovite, Biotite, Phlogopite, Quartz, Orthoclase,Plagioclase, Microcline, Nepheline, Sodalite, Zeolite
Quartz varieties: Chert, Flint, Chalcedony, Agate, Jasper, Amethyst, Rose quartz, Smoky quartz, Rock crystal.
Native Metals/non-metals, Sulfides, Oxides- Copper, Sulfur, Graphite, Pyrite, Corundum, Magnetite Hydroxides, Halides, Carbonates, Sulfates, Phosphates: Psilomelane, Fluorite, Calcite, Malachite, Gypsum, Apatite.
Study of some key silicate minerals under optical microscope and their characteristic properties

SECOND SEMESTER
Course No.: GEOLOGY-C 201
ELEMENTS OF GEOCHEMISTRY

(Contact Hours: 60; Credits: 04)

Full Marks = 70 **[**Semester End Exam (50) + Internal Assessment (20)]
Pass Marks = 28 **[**Semester End Exam (20) + Internal Assessment (08]

Two questions are to be set from each unit. Students have to answer five questions taking one from each Unit

Unit 1: Cosmic abundance of elements; Distribution of elements in solar system and in Earth; Chemical differentiation and composition of the Earth; General concepts about geochemical cycles and mass balance

Unit 2: Concepts of geochemistry; Introduction to properties of elements: The periodic table; Chemical bonding, states of matter and atomic environment of elements; Geochemical classification of elements; Geochemical behaviour of selected elements like Si, Al, K, Na etc.

Unit 3: Layered structure of Earth and geochemistry; Composition of different Earth reservoirs and the nuclides and radioactivity; Conservation of mass, isotopic and elemental fractionation; Concept of radiogenic isotopes in geochronology and isotopic tracers

Unit 4: Element transport Advection and diffusion; Chromatography; Aqueous geochemistry- basic concepts and speciation in solutions, Eh, pH relations; Elements of marine chemistry; Mineral reactions-diagenesis and hydrothermal reactions.

Unit 5: Geochemistry of solid Earth; The solid Earth – geochemical variability of magma and its products. The Earth in the solar system, the formation of solar system; Composition of the bulk silicate Earth and Meteorites

SUGGESTED READINGS:

1. Mason, B. (1986) Principles of Geochemistry. 3rd Edition, Wiley New York.
2. Rollinson, H. (2007) Using geochemical data – evaluation, presentation and interpretation. 2nd Edition. Publisher Longman Scientific & Technical.
3. Walther, J. V. (2009). Essentials of geochemistry. Jones & Bartlett Publishers.
4. Albarède, F. (2003). Geochemistry: an introduction. Cambridge University Press.
5. Faure, Gunter and Teresa M. Mensing (2004). Isotopes: Principles and Applications,Wiley India Pvt. Ltd

SECOND SEMESTER
Course No.: GEOLOGY-C- 201 Lab
PRACTICALS

(40 Contact hours; Credits: 02)
Full marks: 30
Pass marks: 12[Break-up as per AUS guidelines on CBCS]

Types of geochemical data analysis and interpretation of common geochemical plots.
Geochemical analysis of geological materials.
Geochemical variation diagrams and its interpretations.

SECOND SEMESTER
Course No.: GEOLOGY-C 202
STRUCTURAL GEOLOGY

(Contact Hours: 60; Credits: 04)

Full Marks = 70 **[**Semester End Exam (50) + Internal Assessment (20)]
Pass Marks = 28 **[**Semester End Exam (20) + Internal Assessment (08)]

Two questions are to be set from each unit. Students have to answer five questions taking one from each Unit

Unit 1: Structure and Topography
Effects of topography on structural features, Topographic and structural maps; Important representative factors of the map. Planar and linear structures; Concept of dip and strike; Outcrop patterns of different structures. Unconformity: concept, classification and recognition.

Unit 2: Stress and strain in rocks
Concept of rock deformation: Stress and Strain in rocks, Two dimensional strain and stress analysis; types of stress and strain ellipses and ellipsoids; their properties and geological significance. Stereographic projections and their use in structural analysis

Unit 3: Folds
Fold morphology; Geometric and genetic classification of folds; Introduction to the mechanics of folding: Buckling, Bending, Flexural slip and flow folding.

Unit 4: Foliation and lineation
Description and origin of foliations: axial plane cleavage and its tectonic significance.
Description and origin of lineation and relationship with the major structures.

Unit 5: Fractures and faults
Geometric and genetic classification of fractures and faults.
Effects of faulting on the outcrops; Geologic/geomorphic criteria for recognition of faults and fault plane solutions.

SUGGESTED READINGS:

1. Davis, G. R. (1984) Structural Geology of Rocks and Region. John Wiley
2. Billings, M. P. (1987) Structural Geology, 4th edition, Prentice-Hall.
3. Park, R. G. (2004) Foundations of Structural Geology.Chapman & Hall.
4. Pollard, D. D. (2005) Fundamental of Structural Geology. Cambridge University Press.
5. Ragan, D. M. (2009) Structural Geology: an introduction to geometrical techniques (4th Ed). Cambridge University Press (For Practical)
6. Lahee F. H. (1962) Field Geology. McGraw Hill.

SECOND SEMESTER
Course No.: GEOLOGY-C- 202 Lab
PRACTICALS

(40 Contact hours; Credits: 02)
Full marks: 30
Pass marks: 12 [Break-up as per AUS guidelines on CBCS]

Basic idea of topographic contours, Topographic sheets of various scales. Introduction to Geological maps: Lithological and Structural maps Structural contouring and 3-point problems of dip and strike Drawing profile sections and interpretation of geological maps of different complexities Exercises of stereographic projections of mesoscopic structural data (planar, linear, folded etc.)

THIRD SEMESTER
Course No.: GEOLOGY-C 301
IGNEOUS PETROLOGY

(Contact Hours: 60; Credits: 04)

Full Marks = 70 **[**Semester End Exam (50) + Internal Assessment (20)]
Pass Marks = 28 **[**Semester End Exam (20) + Internal Assessment (08)]

Two questions are to be set from each unit. Students have to answer five questions taking one from each Unit

Unit 1: Concepts of Igneous petrology
Introduction to petrology: Heat flow, geothermal gradients through time, origin and nature of magma; Processes of differentiation and evolution of magma; Bowen's reaction principle and reaction series

Unit 2: Forms of Igneous petrology; Classification of igneous rocks; Textures and structures of igneous rocks; Mode of occurrence of Igneous rocks.

Unit 3: Phase diagrams and petrogenesis; Binary and Ternary Phase diagrams in understanding crystal-melt equilibrium in basaltic and granitic magmas; Magma generation in crust and mantle, their emplacement and evolution

Unit 4: Magmatism in different tectonic settings; Magmatism in the oceanic domains (MORB, OIB); Magmatism along the plate margins (Island arcs/continental arcs)

Unit 5: Petrogenesis of Igneous rocks
Petrogenesis of Felsic and Mafic igneous rocks: Komatiites, Granitoids, Basalt, Gabbro; Alkaline rocks, kimberlites and lamproites.

SUGGESTED READINGS:

1. Philpotts, A., & Ague, J. (2009). Principles of Igneous and Metamorphic Petrology. Cambridge University Press.
2. Winter, J. D. (2014). Principles of igneous and metamorphic petrology. Pearson.
3. Rollinson, H. R. (2014). Using geochemical data: evaluation, presentation, interpretation. Routledge.
4. Raymond, L. A. (2002). Petrology: the study of igneous, sedimentary, and metamorphic rocks. McGraw-Hill Science Engineering.
5. McBirney, A. R. (1984). Igneous Petrology. San Francisco (Freeman, Cooper & Company) and Oxford (Oxford Univ. Press),
6. Myron G. Best (2001). Igneous and Metamorphic Petrology,
7. K. G. Cox, J. D. Bell. (1979). The Interpretation of Igneous Rocks. Springer/Chapman & Hall.
8. Bose M.K. (1997). Igneous Petrology.
9. G W Tyrrell. (1926). Principles of Petrology. Springer.

THIRD SEMESTER
Course No.: GEOLOGY-C-Lab 301
PRACTICALS

(40 Contact hours; Credits: 02)
Full marks: 30
Pass marks: 12 [Break-up as per AUS guidelines on CBCS]

Study of important igneous rocks in hand specimens and thin sections- granite, granodiorite, diorite, gabbro, anorthosites, ultramafic rocks, basalts, andesites, trachyte, rhyolite, dacite.

THIRD SEMESTER
Course No.: GEOLOGY-C 302
SEDIMENTARY PETROLOGY

(Contact Hours: 60; Credits: 04)

Full Marks = 70 **[**Semester End Exam (50) + Internal Assessment (20)]
Pass Marks = 28 **[**Semester End Exam (20) + Internal Assessment (08)]

Two questions are to be set from each unit. Students have to answer five questions taking one from each Unit

Unit 1: Origin of sediments

Weathering and sedimentary flux: Physical and chemical weathering, soils and paleosols. Sedimentary cycle, Classification of sedimentary rocks.

Unit 2: Sediment granulometry
Grain size scale, particle size distribution, Environmental connotation; particle shape and fabric

Unit 3: Sedimentary textures and structures
Fluid flow, sediment transport and sedimentary structures: Types of fluids, Laminar vs. turbulent flow, Particle entrainment, transport and deposition. Paleocurrent analysis. Sedimentary structure- Primary and syn-sedimentary structures.

Unit 4: Varieties of sedimentary rocks
Siliciclastic rocks: Conglomerates, sandstones, mudrocks.
Carbonate rocks, controls of carbonate deposition, components and classification of limestone, dolomite and dolomitisation

Unit 5: diagenesis and environment
Concepts of diagenesis; Stages of diagenesis; Compaction and cementation. Sedimentary environments and their classification; Diagnostic characteristics of sedimentary deposits formed in various environments.

SUGGESTED READINGS:
1. Prothero, D. R., & Schwab, F. (2004). Sedimentary geology. Macmillan.
2. Tucker, M. E. (2006) Sedimenary Petrology, Blackwell Publishing.
3. Collinson, J. D. & Thompson, D. B. (1988) Sedimentary structures, Unwin- Hyman, London.
4. Nichols, G. (2009) Sedimentology and Stratigraphy Second Edition. Wiley-Blackwell.

THIRD SEMESTER
Course No.: **GEOLOGY-C-Lab 302**
PRACTICALS

(40 Contact hours; Credits: 02)

Full marks: 30
Pass marks: 12 [Break-up as per AUS guideline on CBCS]

Exercises on sedimentary structures
Particle size distribution and statistical treatment
Paleocurrent analysis
Petrography of clastic and non-clastic rocks through hand specimens and thin sections

THIRD SEMESTER
Course No.: GEOLOGY-C 303
PALAEONTOLOGY

(Contact Hours: 60; Credits: 04)

Full Marks = 70 **[**Semester End Exam (50) + Internal Assessment (20)]
Pass Marks = 28 **[**Semester End Exam (20) + Internal Assessment (08)]

Two questions are to be set from each unit. Students have to answer five questions taking one

from each Unit

Unit 1: Fossilization and fossil record
Fossils: Definition - types of fossils; Nature and importance of fossil record; Fossilization processes and modes of preservation, Mummification, Carbonisation, Petrifaction, Casts and Moulds; Tracks and Trails.

Unit 2: Taxonomy and Species concept
Species concept with special reference to paleontology, Taxonomic hierarchy Theory of organic evolution interpreted from fossil record

Unit 3: Invertebrates
Brief introduction to important invertebrate groups (Bivalvia, Gastropoda, Brachiopoda) and their biostratigraphic significance. Significance of ammonites in Mesozoic biostratigraphy and their paleobiogeographic implications; Functional adaptation in trilobites and ammonoids

Unit 4: Vertebrates
Origin of vertebrates and major steps in vertebrate evolution. Mesozoic reptiles with special reference to origin diversity and extinction of dinosaurs; Evolution of horse and intercontinental migrations. Human evolution

Unit 5: Application of fossils in Stratigraphy
Biozones, index fossils, correlation; Role of fossils in sequence stratigraphy. Fossils and paleoenvironmental analysis; Fossils and paleobiogeography, biogeographic provinces, dispersals and barriers. Paleoecology – fossils as a window to the evolution of ecosystems

SUGGESTED READINGS

1. Raup, D. M., Stanley, S. M., Freeman, W. H. (1971) Principles of Paleontology
2. Clarkson, E. N. K. (2012) Invertebrate paleontology and evolution 4th Edition by Blackwell Publishing.
3. Benton, M. (2009). Vertebrate paleontology. John Wiley & Sons.
4. Shukla, A. C., & Misra, S. P. (1975). Essentials of paleobotany. Vikas Publisher
5. Armstrong, H. A., & Brasier, M.D. (2005) Microfossils. Blackwell Publishing.

THIRD SEMESTER
Course No.: GEOLOGY-C-Lab 303
PRACTICALS

(40 Contact hours; Credits: 02)
Full marks: 30
Pass marks: 12 [Break-up as per AUS guideline on CBCS]

Study of fossils showing various modes of preservation
Study of diagnostic morphological characters, systematic position, stratigraphic position and age of various invertebrate, vertebrate and plant fossils.

FOURTH SEMESTER
Course No.: GEOLOGY-C 401
METAMORPHIC PETROLOGY

(Contact Hours: 60; Credits: 04)

Full Marks = 70 **[**Semester End Exam (50) + Internal Assessment (20)]
Pass Marks = 28 **[**Semester End Exam (20) + Internal Assessment (08)]

Two questions are to be set from each unit. Students have to answer five questions taking one from each Unit

Unit 1: Metamorphism: controls and types.
Definition of metamorphism. Factors controlling metamorphism Types of metamorphism - contact, regional, fault zone metamorphism, impact metamorphism.

Unit 2: Metamorphic facies and grades, Index minerals, Chemographic projections, Metamorphic zones and isograde. Concept of metamorphic facies and grade, Mineralogical phase rule of closed and open system, Structure and textures of metamorphic rocks.

Unit 3: Metamorphism and Tectonism, Relationship between metamorphism and deformation,

Unit 4: Migmatites and their origin, Metasomatism and role of fluids in metamorphism. Metamorphic mineral reactions (prograde and retrograde), Progressive metamorphism of pelites, basic rocks and carbonates.

Unit 5: Metamorphic rock associations- schists, gneisses, khondalites, charnockites, blue schists and Eclogites

SUGGESTED READINGS:
1. Philpotts, A., & Ague, J. (2009). Principles of igneous and metamorphic petrology. Cambridge University Press.
2. Winter, J. D. (2014). Principles of igneous and metamorphic petrology. Pearson.
3. Rollinson, H. R. (2014). Using geochemical data: evaluation, presentation, interpretation. Routledge.
4. Raymond, L. A. (2002). Petrology: the study of igneous, sedimentary, and metamorphic rocks. McGraw-Hill Science Engineering.
5. Yardley, B. W., & Yardley, B. W. D. (1989). An introduction to metamorphic petrology. Longman Earth Science Series.

FOURTH SEMESTER
Course No.: **GEOLOGY-C-Lab 401**
PRACTICALS

(40 Contact hours; Credits: 02)
Full marks: 30
Pass marks: 12 [Break-up as per AUS guidelines on CBCS]

Megascopic and microscopic study (textural and mineralogical) of the following metamorphic rocks:
Low grade metamorphic rocks: serpentinites, albite-epidote-chlorite-quartz schist, slate, talc-tremolite-calcite-quartz schist.
Medium to high grade metamorphic rocks: Gneisses, amphibolite, hornfels, garnetiferous schists, sillimanite-kyanite-bearing rocks, Granulites, eclogite, diopside-forsterite marble.
Laboratory exercises in graphic plots for petrochemistry and interpretation of assemblages.

FOURTH SEMESTER
Course No.: GEOLOGY-C 402
STRATIGRAPHIC PRINCIPLES AND INDIAN STRATIGRAPHY

(Contact Hours: 60; Credits: 04)

Full Marks = 70 **[**Semester End Exam (50) + Internal Assessment (20)]
Pass Marks = 28 **[**Semester End Exam (20) + Internal Assessment (08)]

Two questions are to be set from each unit. Students have to answer five questions taking one from each Unit

Unit 1: Principles of stratigraphy
Fundamentals of litho-, bio- and chrono-stratigraphy
Introduction to concepts of dynamic stratigraphy (chemostratigraphy, seismic stratigraphy, sequence stratigraphy); Brief introduction to the concepts of lithostratigraphy, biostratigraphy, chronostratigraphy, Magnetostratigraphy.

Unit 2: Principles of stratigraphic analysis Facies concept in stratigraphy
Walther's Law of Facies. Concept of paleogeographic reconstruction

Unit 3: Physiographic and tectonic subdivisions of India
Brief introduction to the physiographic and tectonic subdivisions of India. Introduction to Indian Shield, Introduction to Proterozoic basins of India. Geology of Vindhyan and Cudappah basins of India.

Unit 4: Phanerozoic Stratigraphy of India
Paleozoic Succession of Kashmir and its correlatives from Spiti and Zanskar Stratigraphy
Structure and hydrocarbon potential of Gondwana basins.
Mesozoic stratigraphy of India:
a. Triassic successions of Spiti, b. Jurassic of Kutch, c. Cretaceous, successions of Cauvery basins
Cenozoic stratigraphy of India:
a. Kutch basin, b. Siwalik successions, c. Assam & Arakan basin.

Unit 5: Stratigraphic boundaries
Important Stratigraphic boundaries in India – a) Precambrian-Cambrian boundary, b) Permian-Triassic boundary and c) Cretaceous-Tertiary boundary.

SUGGESTED READINGS:
1. Krishnan, M. S. (1982) Geology of India and Burma, CBS Publishers, Delhi
2. Doyle, P. & Bennett, M. R. (1996) Unlocking the Stratigraphic Record. John Wiley
3. Ramakrishnan, M. &Vaidyanadhan, R. (2008) Geology of India Volumes 1 & 2, Geological society of India, Bangalore.
4. Valdiya, K. S. (2010) The making of India, Macmillan India Pvt. Ltd.

FOURTH SEMESTER
Course No.: **GEOLOGY-C-Lab 402**
PRACTICALS

(40 Contact hours; Credits: 02)
Full marks: 30
Pass marks: 12 [Break-up as per AUS guideline on CBCS]

1. Study of geological map of India and identification of major stratigraphic units.
2. Study of rocks in hand specimens from known Indian stratigraphic horizons
3. Drawing various paleogeographic maps of Precambrian time
4. Study of different Proterozoic supercontinent reconstructions.

FOURTH SEMESTER
Course No.: GEOLOGY-C 403
HYDROGEOLOGY

(Contact Hours: 60; Credits: 04)

Full Marks = 70 **[**Semester End Exam (50) + Internal Assessment (20)]
Pass Marks = 28 **[**Semester End Exam (20) + Internal Assessment (08)]

Two questions are to be set from each unit. Students have to answer five questions taking one from each Unit

Unit 1: Introduction and basic concepts
Scope of hydrogeology and its societal relevance; Hydrologic cycle: precipitation, evapo-transpiration, run-off, infiltration and subsurface movement of water. Rock properties affecting groundwater, Vertical distribution of subsurface water. Types of aquifer, aquifer parameters, anisotropy and heterogeneity of aquifers

Unit 2: Groundwater flow
Darcy's law and its validity; Intrinsic permeability and hydraulic conductivity; Groundwater flow rates and flow direction; Laminar and turbulent groundwater flow

Unit 3: Well hydraulics and Groundwater exploration
Basic Concepts (drawdown; specific capacity etc); Elementary concepts related to equilibrium and non-equilibrium conditions for water flow to a well in confined and unconfined aquifers. Surface-based groundwater exploration methods; Introduction to subsurface borehole logging methods

Unit 4: Groundwater chemistry
Physical and chemical properties of water and water quality; Introduction to methods of interpreting groundwater quality data using standard graphical plots; Sea water intrusion in coastal aquifers

Unit 5: Groundwater management
Surface and subsurface water interaction; Groundwater level fluctuations; Basic concepts of water balance studies, issues related to groundwater resources development and management. Rainwater harvesting and artificial recharge of groundwater

FOURTH SEMESTER
Course No.: **GEOLOGY-C-Lab 403**
PRACTICALS

(40 Contact hours; Credits: 02)
Full marks: 30
Pass marks: 12 [Break-up as per AUS guidelines on CBCS]

Preparation and interpretation of water level contour maps and depth to water level maps
Study, preparation and analysis of hydrographs for differing groundwater conditions
Water potential zones of India (map study).
Graphical representation of chemical quality data and water classification (C-S and Trilinear diagrams)
Simple numerical problems related to: determination of permeability in field and laboratory, Groundwater flow, Well hydraulics etc.

SUGGESTED READINGS:

1. Todd, D. K. 2006. Groundwater hydrology, 2nd Ed., John Wiley & Sons, N.Y.
2. Davis, S. N. and De Weist, R.J.M. 1966. Hydrogeology, John Wiley & Sons Inc., N.Y.
3. Karanth K.R., 1987, Groundwater: Assessment, Development and management, Tata McGraw-Hill Pub. Co. Ltd.

FIFTH SEMESTER
Course No.: GEOLOGY-C 501
ECONOMIC GEOLOGY

(Contact Hours: 60; Credits: 04)

Full Marks = 70 **[**Semester End Exam (50) + Internal Assessment (20)]
Pass Marks = 28 **[**Semester End Exam (20) + Internal Assessment (08)]

Two questions are to be set from each unit. Students have to answer five questions taking one from each Unit

Unit 1: Ores, gangue minerals, tenor, grade and lodes; Resources and reserves- Economic and Academic definitions; Primary and secondary classification of mineral deposits. Outline of Lindgren's and Bateman's classification Controls of ore localization – Lithologic, structural and stratigraphic controls.

Unit 2: Mineral deposits and Classical concepts of Ore formation; Mineral occurrence, Mineral deposit and Ore deposit; Historical concepts of ore genesis: Man's earliest vocation- Mining; Plutonist and Neptunist concepts of ore genesis

Unit 3: Mineral exploration
Exploration and exploitation techniques; Remote Sensing, Geophysical and Geochemical Explorations; Geological mapping at different scales, drilling, borehole logs and transverse sections

Unit 4: Structure and texture of ore deposits
Concordant and discordant ore bodies; Endogenous processes: Magmatic concentration, skarns, greisens, and hydrothermal deposits Exogenous processes: weathering products and residual deposits, oxidation and supergene enrichment, placer deposits.

Unit 5: Metallic and Non-metallic ores
Metallogenic provinces and epochs; Important deposits of India including atomic minerals; Non-metallic and industrial rocks and minerals, in India. Introduction to gemstones.

FIFTH SEMESTER
Course No.: **GEOLOGY-C-Lab 501**
PRACTICALS

(40 Contact hours; Credits: 02)
Full marks: 30
Pass marks: 12[Break-up as per AUS guideline on CBCS]

Megascopic identification:
Study of microscopic properties of ore forming minerals (Oxides and sulphides).
Preparation of maps: Distribution of important ores and other economic minerals in India.

SUGGESTED READINGS:

1. Guilbert, J.M. and Park Jr., C.F. (1986) The Geology of Ore deposits. Freeman & Co.
2. Bateman, A.M. and Jensen, M.L. (1990) Economic Mineral Deposits. John Wiley.
3. Evans, A.M. (1993) Ore Geology and Industrial minerals. Wiley
4. Laurence Robb. (2005) Introduction to ore forming processes. Wiley.
5. Gokhale, K.V.G.K. and Rao, T.C. (1978) Ore deposits of India their distribution and processing, Tata-McGraw Hill, New Delhi.
6. Deb, S. (1980) Industrial minerals and rocks of India. Allied Publishers.
7. Sarkar, S.C. and Gupta, A. (2014) Crustal Evolution and Metallogeny in India. Cambridge Publications.

FIFTH SEMESTER
Course No.: GEOLOGY-C 502
GEOMORPHOLOGY

(Contact Hours: 60; Credits: 04)

Full Marks = 70 **[**Semester End Exam (50) + Internal Assessment (20)]
Pass Marks = 28 **[**Semester End Exam (20) + Internal Assessment (08)]

Two questions are to be set from each unit. Students have to answer five questions taking one from each Unit

Unit 1: Introduction to Geomorphology, Endogenic and Exogenic processes; Basic principles of Geomorphology, geomorphological cycles, weathering and erosion; Geomorphic mapping- tools and techniques.

Unit 2: Geoid, Topography, Hypsometry, Global Hypsometry, Major Morphological features Large Scale Topography - Ocean basins, Plate tectonics overview, Large scale mountain ranges (with emphasis on Himalaya).

Unit 3: Surficial Processes and geomorphology, Weathering and associated landforms, Hill slopes; Glacial, Periglacial processes and landforms, Fluvial processes and landforms, Aeolian Processes and landforms, Coastal Processes and landforms,

Unit 4: Endogenic- Exogenic interactions, Rates of uplift and denudation, Tectonics and drainage development, Sea-level change, Long-term landscape development

Unit 5: Overview of Indian Geomorphology, Landforms associated with igneous activities, Extraterrestrial landforms

FIFTH SEMESTER
Course No.: GEOLOGY-C-Lab 502
PRACTICALS

(40 Contact hours; Credits: 02)

Full marks: 30

Pass marks: 12 [Break-up as per AUS guideline on CBCS]

Reading topographic maps, Concept of scale Preparation of a topographic profile, Preparation of longitudinal profile of a river; Preparing Hack Profile; Calculating Stream length gradient index, Morphometry of a drainage basin, Calculating different morphometric parameters, Preparation of geomorphic map , Interpretation of geomorphic processes from the geomorphology of the area.

SUGGESTED READINGS:

1. Robert S. Anderson and Suzzane P. Anderson (2010): Geomorphology - The Mechanics and Chemistry of Landscapes. Cambridge University Press.
2. M.A. Summerfield (1991) Global Geomorphology. Wiley & Sons.

SIXTH SEMESTER
Course No.: GEOLOGY-C 601
ENGINEERING GEOLOGY

(Contact Hours: 60; Credits: 04)

Full Marks = 70 **[**Semester End Exam (50) + Internal Assessment (20)]

Pass Marks = 28 **[**Semester End Exam (20) + Internal Assessment (08)]

Two questions are to be set from each unit. Students have to answer five questions taking one from each Unit

Unit 1: Geology vs. Engineering, Role of Engineering geologists in planning, design and construction of major man-made structural features; Site investigation and characterization

Unit 2: Foundation treatment; Grouting, Rock Bolting and other support mechanisms; Tunnels and Tunneling Methods

Unit 3: Intact Rock and Rock Mass properties
Rock aggregates; Significance as Construction Material

Unit 4: Concept, Mechanism and Significance of Rock Quality Designation (RQD)
Concept, Mechanism and Significance of:
a. Rock Structure Rating (RSR)

b. Rock Mass Rating (RMR)
c. Tunneling Quality Index (Q)
Geological, Geotechnical and Environmental considerations for Dams and Reservoirs

Unit 5: Landslides; Causes, Factors and corrective/Preventive measures; Earthquakes; Causes, Factors and corrective/Preventive measures

SIXTH SEMESTER
Course No.: GEOLOGY-C-Lab 601
PRACTICALS

(40 Contact hours; Credits: 02)
Full marks: 30
Pass marks: 12 [Break-up as per AUS guideline on CBCS]

1. Computation of reservoir area, catchment area, reservoir capacity and reservoir life.
2. Merits, demerits & remedial measures based upon geological cross sections of project sites.
3. Computation of RQD.

SUGGESTED READINGS:

1. Krynin, D.P. and Judd W.R. 1957. Principles of Engineering Geology and Geotechnique, McGraw Hill (CBS Publ).
2. Johnson, R.B. and De Graf, J.V. 1988. Principles of Engineering Geology, John Wiley.
3. Goodman, R.E., 1993. Engineering Geology: Rock in Engineering constructions. John Wiley & Sons, N.Y.
4. Waltham, T., 2009. Foundations of Engineering Geology (3rd Edn.) Taylor & Francis.
5. Bell: F.G-, 2006. Basic Environmental and Engineering Geology Whittles Publishing.
6. Bell, .F.G, 2007. *Engineering Geology,* Butterworth-Heineman.

SIXTH SEMESTER
Course No.: GEOLOGY-C 602
REMOTE SENSING AND GIS

(Contact Hours: 60; Credits: 04)

Full Marks = 70 **[**Semester End Exam (50) + Internal Assessment (20)]
Pass Marks = 28 **[**Semester End Exam (20) + Internal Assessment (08)]

Two questions are to be set from each unit. Students have to answer five questions taking one from each Unit

Unit 1: Photogeology
Types and acquisition of aerial photographs; Scale and resolution; Principles of stereoscopy, relief displacement, vertical exaggeration and distortion
Elements of air photo interpretation
Identification of sedimentary, igneous and metamorphic rocks and various aeolian, glacial, fluvial and marine landforms

Unit 2: Remote Sensing, Concepts in Remote Sensing
Sensors and scanners; Satellites and their characteristics
Data formats- Raster and Vector

Unit 3: Digital Image Processing, Image Errors, Rectification and Restoration, FCC, Image Enhancement, Filtering, Image Rationing, Image classification and accuracy assessment.
GIS integration and Case studies-Indian Examples

Unit 4: GIS, Datum, Coordinate systems and Projection systems
Spatial data models and data editing
Introduction to DEM analysis

Unit 5: GPS, Concepts of GPS
Integrating GPS data with GIS
Applications in earth system sciences.

SIXTH SEMESTER
Course No.: GEOLOGY-C-Lab 602
PRACTICALS

(40 Contact hours; Credits: 02)
Full marks: 30
Pass marks: 12 [Break-up as per AUS guidelines on CBCS]

Aerial Photo interpretation, identification of sedimentary, igneous and metamorphic rocks and various aeolian, glacial, fluvial and marine landforms
Introduction to DIP and GIS softwares.

SUGGESTED READINGS:

1. Demers, M.N., 1997. *Fundamentals of Geographic Information System*, John Wiley & sons. Inc.
2. Hoffmann-Wellenhof, B., Lichtenegger, H. and Collins, J., 2001. *GPS: Theory & Practice*, Springer Wien New York.
3. Jensen, J.R., 1996. *Introductory Digital Image Processing: A Remote Sensing Perspective*, Springer- Verlag.
4. Lillesand, T. M. & Kiefer, R.W., 2007. *Remote Sensing and Image Interpretation*, Wiley.
5. Richards, J.A. and Jia, X., 1999. *Remote Sensing Digital Image Analysis*, Springer-Verlag.

DISCIPLINE SPECIFIC COURSES

FIFTH SEMESTER
Course No.: GEOLOGY-DSE 501
EXPLORATION GEOLOGY

(Contact Hours: 60; Credits: 04)

Full Marks = 70 **[**Semester End Exam (50) + Internal Assessment (20)]
Pass Marks = 28 **[**Semester End Exam (20) + Internal Assessment (08)]

Two questions are to be set from each unit. Students have to answer five questions taking one from each Unit

Unit 1: Mineral Resources

Resource reserve definitions, Mineral resources in industries – historical perspective and present, A brief overview of classification of mineral deposits with respect to processes of formation in relation to exploration strategies.

Unit 2: Prospecting and Exploration,
Principles of mineral exploration, Prospecting and exploration- conceptualization, methodology and stages, Sampling, subsurface sampling including pitting, trenching and drilling, Geochemical exploration.

Unit 3: Evaluation of data
Evaluation of sampling data; Mean, mode, median, standard deviation and variance.

Unit 4: Drilling and Logging
Core and non-core drilling
Planning of bore holes and location of boreholes on ground; Core-logging

Unit 5: Reserve estimations and Errors
Principles of reserve estimation, density and bulk density
Factors affecting reliability of reserve estimation
Reserve estimation based on geometrical models (square, rectangular, triangular and polygon blocks); Regular and irregular grid patterns, statistics and error estimation

FIFTH SEMESTER
Course No.: Geology-DSE-Lab 501
Practicals

(40 Contact hours; Credits: 02)

Full marks: 30
Pass marks: 12 [Break-up as per AUS guidelines on CBCS]

1. Identification of anomaly
2 Geological cross-section
3. Models of reserve estimation

SUGGESTED READINGS:

1. Clark, G.B. 1967. Elements of Mining. 3rd Ed. John Wiley & Sons.
2. Arogyaswami, R.P.N. 1996 Courses in Mining Geology. 4th Ed. Oxford-IBH.
3. Moon, C.J., Whateley, M.K.G., Evans, A.M., 2006, Introduction to Mineral Exploration, Blackwell Publishing.

FIFTH SEMESTER
Course No.: GEOLOGY-DSE 502
INTRODUCTION TO GEOPHYSICS

(Contact Hours: 60; Credits: 04)

Full Marks = 70 **[**Semester End Exam (50) + Internal Assessment (20)]
Pass Marks = 28 **[**Semester End Exam (20) + Internal Assessment (08)]

Two questions are to be set from each unit. Students have to answer five questions taking one from each Unit

Unit 1: Geology and Geophysics

Interrelationship between geology and geophysics, Role of geological and geophysical data in explaining geodynamical features of the earth.

Unit 2: General and Exploration geophysics
Different types of geophysical methods - gravity, magnetic, electrical and seismic; their principles and applications.Concepts and Usage of corrections in geophysical data.

Unit 3: Geophysical field operations
Different types of surveys, grid and route surveys, profiling and sounding techniques
Scales of survey, Presentation of geophysical data.

Unit 4: Application of Geophysical methods
Regional geophysics, oil and gas geophysics, ore geophysics, groundwater geophysics, engineering geophysics.

Unit 5: Geophysical anomalies
Correction to measured quantities, geophysical, anomaly, regional and residual (local) anomalies, factors controlling anomaly, and depth of exploration. Ambiguities in geophysical interpretation, planning and execution of geophysical surveys.

SUGGESTED READINGS:
1. Outlines of Geophysical Prospecting - A manual for geologists by Ramachandra Rao, M.B., Prasaranga, University of Mysore, Mysore, 1975.
2. Exploration Geophysics - An Outline by Bhimasarikaram V.L.S., Association of Exploration Geophysicists, Osmania University, Hyderabad, 1990.
3. Dobrin, M.B. (1984) An introduction to Geophysical Prospecting. McGraw-Hill, New Delhi.
4. Telford, W. M., Geldart, L. P., & Sheriff, R. E. (1990). Applied geophysics (Vol. 1). Cambridge university press.
5. Lowrie, W. (2007). Fundamentals of geophysics. Cambridge University Press.

FIFTH SEMESTER
Course No.: Geology-DSE-Lab 502
Practicals

(40 Contact hours; Credits: 02)

Full marks: 30
Pass marks: 12 [Break-up as per AUS guidelines on CBCS]

Anomaly and background- Graphical method
Study and interpretation of seismic reflector geometry
Problems on gravity anomaly.

SIXTH SEMESTER
Course No.: GEOLOGY-DSE 601
FUEL GEOLOGY

(Contact Hours: 60; Credits: 04)

Full Marks = 70 **[**Semester End Exam (50) + Internal Assessment (20)]
Pass Marks = 28 **[**Semester End Exam (20) + Internal Assessment (08)]

Two questions are to be set from each unit. Students have to answer five questions taking one

from each Unit

Unit 1: Coal
Definition and origin of Coal; Basic classification of coal; Fundamentals of Coal Petrology - Introduction to lithotypes, microlithotypes and macerals in coal; Proximate and Ultimate analysis

Unit 2: Coal as a fuel
Coal Bed Methane (CBM): global and Indian scenario; Underground coal gasification; Coal liquefaction

Unit 3: Petroleum
Chemical composition and physical properties of crudes in nature; Origin of petroleum; Maturation of kerogen; Biogenic and Thermal effect

Unit 4: Petroleum Reservoirs and Traps
Reservoir rocks: general attributes and petrophysical properties. Classification of reservoir rocks - clastic and chemical.
Hydrocarbon traps: definition, anticlinal theory and trap theory
Classification of hydrocarbon traps - structural, stratigraphic and combination
Cap rocks - definition and general properties.

Unit 5: Other fuels
Mode of occurrence and association of atomic minerals in nature; atomic minerals as source of fuel and energy; methods of prospecting atomic minerals; productive geological horizons in India; nuclear power stations of India and future prospects; atomic fuels and environment. Gas Hydrate

SIXTH SEMESTER
Course No.: Geology-DSE-Lab 601
Practicals

(40 Contact hours; Credits: 02)

Full marks: 30
Pass marks: 12 [Break-up as per AUS guidelines on CBCS]

1. Study of hand specimens of coal
2. Reserve estimation of coal
3. Section correlation and identification of hydrocarbon prospect
4. Panel and Fence diagrams

SUGGESTED READINGS:

1. Chandra D. (2007). Chandra's Textbook on applied coal petrology. Jijnasa Publishing House.
2. Shelly R. C. (2014). Elements of Petroleum geology: Third Edition, Academic Press
3. Bjorlykke, K. (1989). Sedimentology and petroleum geology. Springer-Verlag.
4. Bastia, R., & Radhakrishna, M. (2012). Basin evolution and petroleum prospectivity of the continental margins of India (Vol. 59). Newnes.

SIXTH SEMESTER
Course No.: GEOLOGY-DSE 602

EVOLUTION OF LIFE THROUGH TIME

(Contact Hours: 60; Credits: 04)

Full Marks = 70 **[**Semester End Exam (50) + Internal Assessment (20)]
Pass Marks = 28 **[**Semester End Exam (20) + Internal Assessment (08)]

Two questions are to be set from each unit. Students have to answer five questions taking one from each Unit

Unit 1: Origin of life
Possible life sustaining sites in the solar system, life sustaining elements and isotope records
Archean life: Earth's oldest life, Transition from Archean to Proterozoic, the oxygen revolution and radiation of life. Precambrian macrofossils – The garden of Ediacara. The Snow Ball Earth Hypothesis

Unit 2: Paleozoic Life
The Cambrian Explosion. Biomineralization and skeletalization. Origin of vertebrates and radiation of fishes. Early land plants and impact of land vegetation

Unit 3: Mesozoic Life
Life after the largest (P/T) mass extinction, life in the Jurassic seas
Origin of mammals; Rise and fall of dinosaurs; Origin of birds; and spread of flowering plants.

Unit 4: Cenozoic Life
Aftermath of end Cretaceous mass extinction – radiation of placental mammals
Evolution of modern grasslands and co-evolution of hoofed grazers; Rise of modern plants and vegetation

Unit 5: The age of humans
Hominid dispersals and climate setting. Climate Change during the Phanerozoic - continental break-ups and collisions. Plate tectonics and its effects on climate and life; Effects of life on climate and geology.

SIXTH SEMESTER
Course No.: GEOLOGY-DSE LAB 602
EVOLUTION OF LIFE THROUGH TIME

(40 Contact hours; Credits: 02)

Full marks: 30
Pass marks: 12 [Break-up as per AUS guidelines on CBCS]

1. Study of modes of fossil preservation
2. Study of fossils from different stratigraphic levels
3. Exercises related to major evolutionary trends in important groups of animals and plants.

SUGGESTED READINGS:

1. Stanley, S.M., 2008 Earth System History
2. Jonathan I. Lumine W.H.Freeman Earth-Evolution of a Habitable World, Cambridge University
3. Canfield, D.E. & Konhauser, K.O., 2012 Fundamentals of Geobiology Blackwell
4. Cowen, R., 2000 History of Life, Blackwell.

SKILL ENHANCEMENT COURSES

THIRD SEMESTER
Course No.: GEOLOGY-SEC 301
Field Work-I

Full marks: 100
Pass marks: 40

(PART A= 50 Marks; PART B = 50 Marks)

A. Students are required to undertake field work of one week duration in areas having geological exposures and will be trained on the following aspects.

- Orientation of Toposheet in field, marking location in toposheet, Bearing (Front and back).
- Concepts of map reading, Distance, height and pace approximation
- Identification of rock types in field; structures and texture of rocks, Use of hand lens.
- Basic field measurement techniques: Bedding dip and strike, Litholog measurement.
- Reading contours and topography.
- Mapping exercises

B. Industrial Training

Each student is required to submit a report on both the components A &B duly certified by the Teacher in-Charge (s) of the Field tour etc. and the Head of Department and has to take a Seminar Presentation on both Part-A & B.

FOURTH SEMESTER
Course No.: GEOLOGY-SEC 401
Field Work-II

Full marks: 100
Pass marks: 40
(PART A =50 Marks ; PART B = 50 Marks)

A. Students are required to undertake a specific theme based field work of one week duration such as *Geological Mapping; Economic Geology field; Himalayan Geology field; Precambrian Geology field; Stratigraphy and Paleontology related field etc*..

B. Laboratory based exercises ; thin sections studies of minerals and rocks ; polished sections of coal and ores ; problems on structural geology.

Each student is required to submit a report on both the components A &B duly certified by the Teacher in-Charge (s) of the Field tour etc. and the Head of Department and has to take a Seminar Presentation on both Part-A & B.

Discipline Specific core/ Generic Elective Courses

FIRST SEMESTER
Course No.: Geology-DSC-101/ Geology-GE-101
PHYSICAL AND STRUCTURAL GEOLOGY

(Contact Hours: 60; Credits: 04)

Full Marks = 70 **[**Semester End Exam (50) + Internal Assessment (20)]
Pass Marks = 28 **[**Semester End Exam (20) + Internal Assessment (08)]

Two questions are to be set from each unit. Students have to answer five questions taking one from each Unit

Unit-1: Introduction to Geology and its scope, Earth and Solar system: origin, size, shape, mass, density and its atmosphere. A brief account of various theories regarding the origin and age of the earth; Brief idea of interior of earth and its composition. Weathering and erosion: factors, types and their effects

Unit-2: Earthquakes: nature of seismic waves, their intensity and magnitude scale; Origin of earthquake; Volcanoes: types, products and causes of volcanism;.

Unit-3: Introduction to Structural Geology; contours, topographic and geological maps; Elementary idea of bed, dip and strike; Outcrop, effects of various structures on outcrop. Clinometer/Brunton compass and its use.

Unit-4: Elementary idea of types of deformation; Folds: nomenclature and types of folds; geometrical and genetic classifications of fold

Unit-5: Faults: nomenclature, geometrical and genetic classifications, normal, thrust and slip faults; definition, kinds and significance of joints and unconformity.

Books Recommended:
1. Arthur Holmes, 1992. Principles of Physical Geology. Chapman and Hall, London.
2. Miller, 1949. An Introduction to Physical Geology. East West Press Ltd.
3. Spencer, E.V., 1962. Basic concepts of Physical Geology. Oxford & IBH.
4. Mahapatra, G.B., 1994. A text book of Physical geology. CBS Publishers.
5. Billings, M.P., 1972. Structural Geology. Prentice Hall.
6. Davis, G.R., 1984. Structural Geology of Rocks and Region. John Wiley
7. Hills, E.S., 1963. Elements of Structural Geology. Farrold and Sons, London.
8. Singh, R. P., 1995. Structural Geology, A Practical Approach. Ganga Kaveri Publ., Varanasi.

FIRST SEMESTER
Course No.: Geology-DSC-Lab 101/ Geology-GE- Lab 101
PRACTICALS

(40 Contact hours; Credits: 02)
Full marks: 30
Pass marks: 12 [Break-up as per AUS guidelines on CBCS]

- **Physical Geology:**

Study of important geomorphological models; Reading topographical maps of the Survey of India; Identification of geomorphic features.

• **Structural Geology:**
Study of clinometers/Brunton compass; Identification of different types of folds/faults from block models; Exercises on structural problems: preparation of cross section profile from a geological map.

• **Laboratory record:**
• **Viva Voce:**

SECOND SEMESTER
Course No.: Geology-DSC-201/ Geology-GE-201
CRYSTALLOGRAPHY AND MINERALOGY

(Contact Hours: 60; Credits: 04)

Full Marks = 70 **[**Semester End Exam (50) + Internal Assessment (20)]
Pass Marks = 28 **[**Semester End Exam (20) + Internal Assessment (08)]

Two questions are to be set from each unit. Students have to answer five questions taking one from each Unit

Unit-1: Crystals and their characters; Crystal form, face, edge, solid angle; Interfacial angle and their measurements; Crystallographic axes and angles. Crystal parameters, Weiss and Miller system of notations.

Unit-2: Symmetry elements and description of normal class of Isometric, Tetragonal, Hexagonal, Trigonal, Orthorhombic, Monoclinic and Triclinic systems.

Unit-3: Introduction to Mineralogy, Definition and characters of mineral. Common physical properties of minerals; Chemical composition and diagnostic physical properties of minerals such as: Quartz, Orthoclase, Microcline, Hypersthene, Hornblende, Garnet, Muscovite, Biotite, Chlorite, Olivine, Epidote, Calcite.

Unit-4: Polarizing microscope, its parts and functioning; Ordinary and polarized lights; Common optical properties observed under ordinary, polarized lights and crossed nicols.

Unit-5: Optical properties of some common rock forming minerals (Quartz, Orthoclase, Microcline, Olivine, Augite, Hornblende, Muscovite, Biotite, Garnet, Calcite).

Books Recommended:

1. Dana, E.S. and Ford, W.E., 2002. A textbook of Mineralogy (Reprints).
2. Flint, Y., 1975. Essential of crystallography, Mir Publishers.
3. Phillips, F.C., 1963. An introduction to crystallography. Wiley, New York.
4. Berry, L.G., Mason, B. and Dietrich, R.V., 1982. Mineralogy. CBS Publ.
5. Nesse, D.W., 1986. Optical Mineralogy. McGraw Hill.
6. Read, H.H., 1968. Rutley's Element of Mineralogy (Rev. Ed.). Thomas Murby and Co.
7. Berry and Mason, 1961. Mineralogy. W.H. Freeman & Co.
8. Kerr, B.F., 1995. Optical Mineralogy 5th Ed. Mc Graw Hill, New York

SECOND SEMESTER
Course No.: Geology-DSC-Lab 201/ Geology-GE-Lab 201
Practicals

(40 Contact hours; Credits: 02)

Full marks: 30
Pass marks: 12 [Break-up as per AUS guidelines on CBCS]

• Crystallography:
Study of symmetry elements of normal class of Isometric, Tetragonal, Hexagonal, Trigonal, Orthorhombic, Monoclinic and Triclinic systems.

• Mineralogy:
Study of physical properties of minerals mentioned in theory course. Use of polarizing microscope; Study of optical properties of common rock forming minerals mentioned in theory course.

• Laboratory record:

• Geological Field Training:
Students will be required to carry out 03 days field work in a suitable geological area to study the elementary aspects of field geology and submit a report thereon.

• Viva voce:

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THIRD SEMESTER
Course No.: Geology-DSC-301/ Geology-GE-301
PETROLOGY

(Contact Hours: 60; Credits: 04)

Full Marks = 70 **[**Semester End Exam (50) + Internal Assessment (20)]
Pass Marks = 28 **[**Semester End Exam (20) + Internal Assessment (08)]

Two questions are to be set from each unit. Students have to answer five questions taking one from each Unit

Unit-1: Magma: definition, composition, types and origin; Forms of igneous rocks; textures of igneous rocks. Reaction principle; Differentiation and Assimilation; Crystallization of unicomponent and bicomponent (mix-crystals); Bowen's reaction series.

Unit-2: Mineralogical and chemical classification of igneous rocks; detailed petrographic description of Granite, Granodiorite, Rhyolite, Syenite, Phonolite, Diorite, Gabbro.

Unit-3: Processes of formation of sedimentary rocks; Classification, textures and structures of sedimentary rocks. Petrographic details of important siliciclastic and carbonate rocks such as - conglomerate, breccia, sandstone, greywacke, shale, limestones.

Unit-4: Process and products of. metamorphism; Type of metamorphism. Factors, zones and grade of metamorphism; Textures, structures and classification of metamorphic rocks.

Unit-5: Petrographic details of some important metamorphic rocks such as - slate, schists, gneiss, quartzite, marble.

Books Recommended:

1. Turner, F.J. & Verhoogen, J., 1960, Igneous & Metamorphic petrology. McGraw Hill Co.
2. Bose, M.K., 1997. Igneous petrology. World press
3. Tyrell, G. W., 1989. Principles of Petrology. Methuren and Co (Students ed.).
4. Ehlers, WG, and Blatt, H., 1987. Petrology, Igneous, Sedimentary and Metamorphic rocks, CBS Publishers
5. Moorhouse, WW., 1969. The study of rocks in thin sections. Harper and sons.
6. Friedman & Sanders, 1978. Principles of Sedimentology. John Wiley and sons.
7. Pettijohn, F.J., 1975. Sedimentary rocks, Harper & Bros. 3rd Ed.
8. Prasad, C., 1980. A text book of sedimentology.
9. Sengupta. S., 1997. Introduction to sedimentology. Oxford-IBH.
10. Turner, F.J., 1980. Metamorphic petrology. McGraw Hill.
11. Mason, R., 1978. Petrology of Metamorphic Rocks. CBS Publ.
12. Winkler, H.G.C., 1967. Petrogenesis of Metamorphic Rocks. Narosa Publ.

THIRD SEMESTER
Course No.: Geology-DSC-Lab 301/ Geology-GE-Lab 301
Practicals

(40 Contact hours; Credits: 02)

Full marks: 30
Pass marks: 12 [Break-up as per AUS guidelines on CBCS]

Igneous Petrology:
Identification of rocks: On the basis of their physical properties in hand specimen; and optical properties in thin sections.
Sedimentary and metamorphic Petrology:
Identification of sedimentary and metamorphic rocks both in hand specimen and thin sections.

- **Laboratory record:**
- **Viva Voce**

FOURTH SEMESTER
Course No.: Geology-DSC-401/ Geology-GE-401
STRATIGRAPHY AND PALAEONTOLOGY

(Contact Hours: 60; Credits: 04)

Full Marks = 70 **[**Semester End Exam (50) + Internal Assessment (20)]
Pass Marks = 28 **[**Semester End Exam (280 + Internal Assessment (08)]

Two questions are to be set from each unit. Students have to answer five questions taking one from each Unit

Unit I: Definition, Principle of stratigraphy; Geological Time Scale and stratigraphic classification; Physiographic division of India.

Unit 2: Study of following Precambrian succession: Dharwar, Cuddapha, Vindhyan and Delhi Supergroups; Brief idea of Palaeozoic succession of northwestern Himalaya; Triassic of Spiti; Mesozoic type seccession of Kutch and Rajasthan; Cretaceous of Tiruchirapalli;

Unit 3: Study of following type localities: Gondwana and Deccan Trap. Palaeogene-Neogene sequences of northwest Himalaya and Assam.

Unit-4: Palaeontology: definition, Fossils: definition, characters, binomial nomenclature in taxonomy, mode of preservation, condition of fossilization and significance of fossils;.

Unit 5: Morphology and geological distribution of brachiopods, pelecypods, cephalopods, Trilobite, echinoidea; Evolutionary history of horse; Morphology, distribution and significance of Gondwana flora.

Books Recommended:

1. Wadia, D., 1973. Geology of India. Mc Graw Hill Book co.
2. Krishnan, M.S., 1982. Geology of India and Burma, 6th Edition. CBS Publ.
3. Ravindra Kumar, 1985. Fundamentals of Historical Geology & Stratigraphy of India. Wiley Eastern.
4. Shrock, R.R. & Twenhoffel, W.H., 1952. Principles of Invertebrate Paleontology. CBS Publ.
5. Swinerton, HH., 1961. Outlines of Paleontology. Edward Arnold Publishers
6. Jain, P.C. & Anantharaman, M.S., 1983. Paleontology: Evolution & Animal Distribution. Vishal Publ.
7. Lehmann, U., 1983. Fossil Invertebrate. Cambridge Univ. Press.
8. Rastogi, 1988. Organic evolution. Kedrnath and Ramnath Publ.

FOURTH SEMESTER
Course No.: Geology-DSC-Lab 401/ Geology-GE-Lab 401
Practicals

(40 Contact hours; Credits: 02)

Full marks: 30
Pass marks: 12 [Break-up as per AUS guidelines on CBCS]

I. Morphological characters, systematic position and age of fossil genera pertaining to brachiopods, pelecypods, cephalopods, trilobite and Echinacea.
II. Preparation of lithostratigraphic maps of India showing distribution of important geological formations.

- **Laboratory record:**
- **Viva Voce**

DISCIPLINE SPECIFIC ELECTIVE COURSE

FIFTH SEMESTER
Course No.: GEOLOGY-DSE 501
EXPLORATION GEOLOGY

(Contact Hours: 60; Credits: 04)

Full Marks = 70 **[**Semester End Exam (50) + Internal Assessment (20)]
Pass Marks = 28 **[**Semester End Exam (20) + Internal Assessment (08)]

Two questions are to be set from each unit. Students have to answer five questions taking one from each Unit

Unit 1: Mineral Resources
Resource reserve definitions, Mineral resources in industries – historical perspective and present, A brief overview of classification of mineral deposits with respect to processes of formation in relation to exploration strategies.

Unit 2: Prospecting and Exploration,
Principles of mineral exploration, Prospecting and exploration- conceptualization, methodology and stages, Sampling, subsurface sampling including pitting, trenching and drilling, Geochemical exploration.

Unit 3: Evaluation of data
Evaluation of sampling data; Mean, mode, median, standard deviation and variance.

Unit 4: Drilling and Logging
Core and non-core drilling
Planning of bore holes and location of boreholes on ground; Core-logging

Unit 5: Reserve estimations and Errors
Principles of reserve estimation, density and bulk density
Factors affecting reliability of reserve estimation
Reserve estimation based on geometrical models (square, rectangular, triangular and polygon blocks); Regular and irregular grid patterns, statistics and error estimation

FIFTH SEMESTER
Course No.: Geology-DSE-Lab 501
Practicals

(40 Contact hours; Credits: 02)

Full marks: 30
Pass marks: 12 [Break up as per AUS guidelines on CBCS]

1. Identification of anomaly
2 Geological cross-section
3. Models of reserve estimation

SUGGESTED READINGS:
1. Clark, G.B. 1967. Elements of Mining. 3rd Ed. John Wiley & Sons.
2. Arogyaswami, R.P.N. 1996 Courses in Mining Geology. 4th Ed. Oxford-IBH.

3. Moon, C.J., Whateley, M.K.G., Evans, A.M., 2006, Introduction to Mineral Exploration, Blackwell Publishing.

SIXTH SEMESTER
Course No.: GEOLOGY-DSE 601
FUEL GEOLOGY

(Contact Hours: 60; Credits: 04)

Full Marks = 70 **[**Semester End Exam (50) + Internal Assessment (20)]
Pass Marks = 28 **[**Semester End Exam (20) + Internal Assessment (08]

Two questions are to be set from each unit. Students have to answer five questions taking one from each Unit

Unit 1: Coal
Definition and origin of Coal; Basic classification of coal; Fundamentals of Coal Petrology - Introduction to lithotypes, microlithotypes and macerals in coal; Proximate and Ultimate analysis

Unit 2: Coal as a fuel
Coal Bed Methane (CBM): global and Indian scenario; Underground coal gasification; Coal liquefaction

Unit 3: Petroleum
Chemical composition and physical properties of crudes in nature; Origin of petroleum; Maturation of kerogen; Biogenic and Thermal effect

Unit 4: Petroleum Reservoirs and Traps
Reservoir rocks: general attributes and petrophysical properties. Classification of reservoir rocks - clastic and chemical.
Hydrocarbon traps: definition, anticlinal theory and trap theory
Classification of hydrocarbon traps - structural, stratigraphic and combination
Cap rocks - definition and general properties.

Unit 5: Other fuels
Mode of occurrence and association of atomic minerals in nature; atomic minerals as source of fuel and energy; methods of prospecting atomic minerals; productive geological horizons in India; nuclear power stations of India and future prospects; atomic fuels and environment. Gas Hydrate

SIXTH SEMESTER
Course No.: Geology-DSE-Lab 601
Practicals

(40 Contact hours; Credits: 02)

Full marks: 30
Pass marks: 12 [Break-up as per AUS guidelines on CBCS]

1. Study of hand specimens of coal
2. Reserve estimation of coal
3. Section correlation and identification of hydrocarbon prospect

4. Panel and Fence diagrams

SUGGESTED READINGS:

1. Chandra D. (2007). Chandra's Textbook on applied coal petrology. Jijnasa Publishing House.
2. Shelly R. C. (2014). Elements of Petroleum geology: Third Edition, Academic Press
3. Bjorlykke, K. (1989). Sedimentology and petroleum geology. Springer-Verlag.
4. Bastia, R., & Radhakrishna, M. (2012). Basin evolution and petroleum prospectivity of the continental margins of India (Vol. 59). Newnes.

SKILL ENHANCEMENT COURSE

THIRD SEMESTER
Course No.: GEOLOGY-SEC 301
GEOMORPHOLOGY & GEOTECTONICS

(Contact Hours: 60; Credits: 04)

Full Marks = 100 [Semester End Exam (70) + Internal Assessment (30)]
Pass Marks = 40 [Semester End Exam (28) + Internal Assessment (12)]

Two questions are to be set from each unit. Students have to answer five questions taking one from each Unit

Unit-I: Basic principles of Geomorphology, geomorphological cycles, weathering and erosion; Geomorphic mapping- tools and techniques.

Unit-II: Epigene/exogenic processes: degradation and aggradation. Hypogene/endogenic processes; Diastrophism and volcanism, Extraterrestrial processes; Geological work of wind, glacier, river, underground water and ocean.

Unit-III: Earth as a dynamic system. Elementary idea of continental drift, sea-floor spreading and mid-oceanic ridges. Paleomagnetism and its application.

Unit-IV: Plate Tectonics: the concept, plate margins, orogeny, deep sea trenches, island arcs and volcanic arcs.

UNIT V: Important Orogenic belts of the world; Himalayan orogeny. Tectonic framework of India with special reference to Northeast India; Neotectonics and its importance.

Books Recommended:

1. Allen, P., 1997. Earth Surface Processes. Blackwell
2. Bloom, A.L., 1998. Geomorphology: A systematic Analysis of Late Cenozoic Landforms (3rd Edition). Pearson Education, Inc.
3. Keary, P. and Vine, F.J., 1997. Global Tectonics. Blackwell and crustal evolution. Butterworth-Heinemann.
4. Kale, V.S. and Gupta, A., 2001. Introduction to Geomorphology. Orient Longman Ltd.
5. Moores, E and Twiss. R.J., 1995. Tectonics. Freeman.
6. Patwardhan, A. M., 1999. The Dynamic Earth System. Prentice Hall.
7. Summerfied, M.A., 2000. Geomorphology and Global tectonic. Springer Verlag.
8. Valdia, K.S., 1988. Dynamic Himalaya. Universities Press, Hyderabad.
9. WD Thornbury, 2002. Principles of Geomorphology. CBS Publ. New Delhi.

FOURTH SEMESTER
Course No.: GEOLOGY-SEC 401
ENVIRONMENTAL GEOLOGY

(Contact Hours: 60; Credits: 04)

Full Marks = 100 **[**Semester End Exam (70) + Internal Assessment (30)]
Pass Marks = 40 **[**Semester End Exam (28) + Internal Assessment (12)]

Two questions are to be set from each unit. Students have to answer five questions taking one from each Unit

Unit-I: Earth and its spheres: atmosphere, hydrosphere, lithosphere, biosphere and Man; Earth Material.

Unit –II: Composition of air, structure of atmosphere, air pollution, effects of air pollution on human health. Soil: Formation, erosion and quality degradation through usage of fertilizer, drainage and irrigation. Soil contamination due to urbanization, industrialization. Basic tenets of environmental laws.

Unit-III: Energy budget: Solar radiation; Global environments: coastal, riverine, desertic, tropical, cold, polar; Concept of global warming and climate change.

Unit-IV: Geoloigcal hazards: Earthquakes, volcanism, landslides, avalanches, floods, droughts; Hazard mitigation.

Unit V: Resource Management: Energy resources (Conventional and non-conventional), watershed management, landuse planning, management of water resources, land reclamation.

Books Recommended:

1. Verma, V.K., 1986. Geomorphology Earth surface processes and form. McGraw Hill.
2. Chorley, R. J., 1984. Geomorphology. Methuen.
3. Selby, M.J., 1996. Earths Changing Surface. Oxford University Press UK.
4. Thornbury W. D., 1997. Principles of Geomorphology Wiley Eastern Ltd., New Delhi.
5. Valdiya, K. S., 1987. Environmental Geology - Indian Context. Tata McGraw Hill New Delhi.
6. Keller, E. A., 2000. Environmental Geology. Shales E. Merril Publishing Co., Columbus, Ohio.
7. Montgomery, C., 1984. Environmental Geology. John Wiley and Sons, London.
8. Bird, Eric, 2000. Coastal Geomorphology: An Introduction. John Wiley & Sons, Ltd. Singapore.
9. Liu, B.C., 1981. Earthquake Risk and Damage, Westview.

FIFTH SEMESTER
Course No.: GEOLOGY-SEC 501
GEOCHEMISTRY

(Contact Hours: 60; Credits: 04)

Full Marks = 100 [Semester End Exam (70) + Internal Assessment (30)]
Pass Marks = 40 [Semester End Exam (28) + Internal Assessment (12)]

Two questions are to be set from each unit. Students have to answer five questions taking one from each Unit

Unit-I: Introduction to geochemistry: basic knowledge about crystal chemistry. Types of chemical bonds, coordination number; Colloids in geological systems, ion exchanges and geological evidence for earlier colloids; Elementary idea of Periodic Table.

Unit-II: Cosmic abundance of elements; Composition of the planets and meteorites; Geochemical evolution of the earth and geochemical cycles;

Unit-III: Gold Schmidt's geochemical classification of elements; Distribution of major, minor and trace elements in igneous, metamorphic and sedimentary rocks.

Unit-IV: Elements of geochemical thermodynamics; Isomorphism and polymorphism; Isotope geochemistry.

Unit – V: Meteorites - Classification composition and their origin. Geochemical structure of the earth. Geochemical fractionation of trace elements in magmatic processes Biochemical classification of element and geochemical cycles

Books Recommended:
1. Hoefs, J., 1980. Stable Isotope Geochemistry. Springer-Verlag.
2. Klein, C. and Hurlbut, C.S., 1993. Manual of Mineralogy. John Viley and Sons, New York.
3. Krauskopf, K.B., 1967. Introduction to Geochemistry. McGraw Hill.
4. Mason, B. and Moore, C.B., 1991. Introduction to Geochemistry. Wiley Eastern.
5. Rollinson, H.R., 1993. Using geochemical data: Evaluation, Presentation, and Interpretation. Longman.

SIXTH SEMESTER
Course No.: GEOLOGY-SEC 601
PHOTOGEOLOGY & REMOTE SENSING

(Contact Hours: 60; Credits: 04)

Full Marks = 100 [Semester End Exam (70) + Internal Assessment (30)]
Pass Marks = 40 [Semester End Exam (28) + Internal Assessment (12)]

Two questions are to be set from each unit. Students have to answer five questions taking one from each Unit

Unit-I: Elementary idea about photogeology: electro-magnetic spectrum, types & geometry of aerial photographs; factors affecting aerial photography; types of camera, film and filters; factors affecting scale.

Unit-II: Fundamentals of remote sensing; remote sensing systems; remote sensing sensors; signatures of rocks, minerals and soils. Application of remote sensing in geoscience and geomorphological studies.

Unit-III: Types of Indian and Foreign Remote Sensing Satellites, Indian remote sensing satellite (IRS) series, Landsat Series; Microwave Remote sensing

Unit – IV: Digital image processing; fundamental steps in image processing; elements of pattern recognition and image classification.

Unit-V: Introduction to Geographic Information System (GIS); components of GIS; product generation in GIS; tools for map analysis; integration of GIS with remote sensing.

Books Recommended:

1. Bhatta, B., 2008. Remote Sensing and GIS. Oxford, New Delhi.
2. Gupta, R.P., 1990. Remote Sensing Geology. Springer Verlag.
3. Lilleasand, T.M. and Kiffer, R.W., 1987. Remote Sensing and Image Interpretation. John Wiley.
4. Pandey, S.N., 1987. Principles and Application of Photogeology. Wiley Eastern, New Delhi.
5. Sabbins, F.F., 1985. Remote Sensing – Principles and Applications. Freeman.
6. Siegal, B.S. and Gillespie, A.R., 1980. Remote Sensing in Geology. John Wiley.
7. Rampal K.K. 1999. Hand book of aerial photography and interpretation. Concept publication.

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